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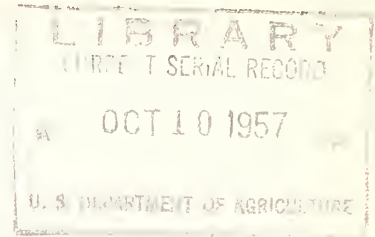
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United States Department of Agriculture
Agricultural Research Service



Report
of
ANNUAL CORN AND WHEAT UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
and
Corn Industries Research Foundation
Technical Committee

Peoria, Illinois

June 11, 1957

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I. LIST OF ATTENDANCE

CORN INDUSTRIES RESEARCH FOUNDATION TECHNICAL COMMITTEE

Corn Industries Research Foundation, Inc., Washington 6, D. C.

Mr. N. F. Kennedy
Mr. J. T. Goodwin, Jr.
Mr. F. J. Hosking
Mr. W. J. Hoover

American Maize-Products Company, Roby, Indiana

Dr. J. W. Evans

Anheuser-Busch, Inc., St. Louis, Missouri

Dr. B. L. Scallet

Clinton Corn Processing Company, Clinton, Iowa

Mr. G. T. Peckham, Jr.

Corn Products Refining Company

Dr. R. G. Ruark (New York, New York)
Dr. A. L. Elder (Argo, Illinois)
Dr. Harry Gehman (Argo, Illinois)
Mr. R. J. Smith (Argo, Illinois)

The Hubinger Company, Keokuk, Iowa

Mr. L. H. Elizer

National Starch Products, Inc., Plainfield, New Jersey

Dr. C. G. Caldwell

Penick and Ford, Ltd., Inc., Cedar Rapids, Iowa

Dr. C. C. Kesler
Mr. E. T. Hjermstad
Mr. W. C. Black

A. E. Staley Manufacturing Company, Decatur, Illinois

Dr. T. L. Gresham
Dr. J. A. Bralley

Union Starch and Refining Company, Inc., Granite City, Illinois

Dr. R. E. Pyle
Dr. James Lenney

NORTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION:

Dr. W. Dayton MacLay, Director
Mr. C. E. Rist, Assistant Director
Mr. K. R. Majors, Extension Grain Utilization Specialist

Analytical and Physical Chemistry and Physics Section

Dr. Richard Wiebe, Head
Mr. C. H. VanEtten

Cereal Crops Section

Dr. F. R. Senti, Head
Mr. G. E. Babcock
Dr. R. J. Dimler
Mr. J. E. Hodge
Mr. B. T. Hofreiter
Dr. A. R. Jeanes
Dr. Samuel Levine
Mr. E. Lukasik
Dr. M. M. MacMasters
Dr. C. L. Mehltrittter
Dr. R. L. Mellies
Miss E. M. Montgomery
Mr. J. C. Rankin
Mr. J. W. Sloan
Dr. N. W. Taylor
Dr. M. J. Wolf
Mr. H. F. Zobel

Engineering and Development Section

Mr. E. L. Griffin, Jr., Head
Mr. R. A. Anderson
Mr. C. Vojnovich
Mr. F. C. Wohlrabe

Fermentation Section

Dr. R. W. Jackson, Head
Dr. R. F. Anderson
Dr. H. H. Hall
Dr. L. L. Wallen
Dr. F. H. Stodola

Forage and Agricultural Residues Section

Dr. H. J. Dutton, Head
Dr. L. A. Gugliemelli
Dr. R. L. Lohmar
Dr. C. R. Russell

New Crops Research

Dr. I. A. Wolff, In Charge

Oilseeds Section

Dr. J. C. Cowan, Head
Dr. L. H. Mason
Dr. A. K. Smith

II. United States Department of Agriculture
Agricultural Research Service

PROGRAM

ANNUAL CORN AND WHEAT UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
and
Corn Industries Research Foundation
Technical Committee

Peoria, Illinois
June 11, 1957

Morning Session - 10:00 a. m.

Introduction	W. D. MacLay
General Program on Cereal Grains	F. R. Senti
Properties of Starch Components Separated by Sedimentation Fractionation	E. M. Montgomery
Glucose Derivatives as Bread Softeners	C. L. Mehltretter
Corn Cleaning Methods Batter Process (Demonstrations in Pilot Plant).....	E. L. Griffin
Composition of the Cementing Layer and Adjacent Tissues as Related to Germ- Endosperm Separation in Corn	M. J. Wolf

Lunch - 12:45 p. m.

Afternoon Session - 2:15 p.m.

Type Reactions of Microorganisms	L. L. Wallen
Cereal Grain Lipids	L. H. Mason
Action of Various Oxidants on Periodate Oxidized Starch	R. L. Mellies
Discussion of Presentation of Reports by Representatives of the Corn Industries	
Discussion of Important Problems in Grain Utilization Research	

III. INTRODUCTION (W. Dayton Maclay)

Dr. Maclay extended a cordial welcome to members of the CIRF Technical Committee and guests at the Fifth Annual Meeting of the current series, and stated that we had found information and suggestions coming out of these meetings most helpful in the development of our research program on corn and wheat. The CIRF representatives were introduced by Mr. Kennedy, followed by individual introductions of the Northern Division participants.

Stating that the past year had been one of examination and evaluation in the Agricultural Research Service as related to research programming, Dr. Maclay then briefly reviewed activities in this field in the ARS, particularly as related to utilization research. This included an explanation of the objectives, organization, and plans for release of the report of the Committee on Research Evaluation (CORE); the study of the Utilization Research Committee on a program for the expansion of markets for surplus agricultural commodities through utilization research; and the Interim Report to the Congress from the Commission on Increased Industrial Use of Agricultural Products, pursuant to Public Law 540, 84th Congress. Following this, the organization of ARS as announced by Dr. B. T. Shaw in February to better carry out the projected programs was shown in a series of slides.

Directing attention to the research program of the Northern Division, Dr. Maclay stated that the basic premise of our research, like all utilization research, was to contribute to solution of the problem of imbalance of agricultural production in relation to market demands. He pointed out that although the total excess production is of an order of but 5 percent, the figure varied greatly with individual crops--the surpluses in wheat, corn, and cotton being particularly burdensome at present. In the case of cereals, more than 60 percent of the CCC inventory is in this category, and 80 percent of the acreage in the Soil Bank Reserve has been from land taken out of grain production. The importance of cereal grains to the agricultural economy of the Northern Region is shown by the fact that 73 percent of the 1954 production of the principal cereal grains was grown in our region. Oilseed crops--soybean and flaxseed, in particular--are the best current replacement crops for grains in the Northern Region. Acreage has increased from 8.7 to 27.7 million since 1937. With this as a background, the Northern Division's research program has been developed with a fourfold approach:

1. Direct uses of cereal grains through conversion into new and improved feed and industrial products.
2. Maintain current use levels of oilseed replacement crops and develop new industrial products.
3. Discover and develop new crops that can be used and grown with profit.
4. Increase emphasis on fundamental research to provide new concepts, new reactions and new products.

Dr. Maclay stated that organization of the Division is being built around these four objectives. He elaborated on the emphasis being given to basic research, and differentiated between that which will be carried out

within the Branches--that designed to directly support the research program of the particular commodity Branch, as contrasted to that in the Pioneering Research Group which will be of a less committed type and will have the overall objective of developing fundamental facts, principles, and concepts to provide a broad basis for a more effective research effort in the field of utilization of agricultural crops.

IV. GENERAL PROGRAM ON CEREAL GRAINS (F. R. Senti)

The reports on specific phases of our research program on cereal grains which are to be presented during this meeting will give a sampling of the work on cereals which is in progress in at least four of the Sections of the Northern Division. The present discussion will provide a somewhat broader view of our program on corn, wheat, and other grains.

Our research on cereals can be classified under the headings:

- Research on whole corn
- Research on starch and dextrose
- Fermentation research
- Research on wheat
- Research on small grains

Time will not permit a detailed discussion of our work in each of these areas but the principal lines of work can be mentioned to indicate the scope and emphasis of our research program at the present time. We have eleven research projects in cereals which are being carried out under contract at State Agricultural Experiment Stations, Universities, and research institutes.

A. Research on whole corn

Our principal projects dealing with corn in the form of whole grain are as follows:

1. Corn sanitation (methods to be demonstrated later this morning)
2. Effect of artificial drying on wet-milling properties
3. Composition (minor constituents, odor and flavor of corn, compilation of composition data)
4. Kernel structure and histochemistry (some results to be reported this morning)
5. High amylose corn

B. Starch research

1. Periodate oxidized starch
 - a. Preparation for evaluation purposes
 - b. Properties of dialdehyde starch
 - c. Oxidation to dicarboxyl starch
(A report on this work to be made this afternoon)
2. Physical properties of starch
 - a. Fractionation and properties of isolated components of starches (to be reported this morning)
 - b. Hydration and crystallization phenomena in concentrated starch gels

- c. Proportion of crystalline regions and size of these regions in various granular starches
 - d. Solution properties of periodate oxidized amylose and amylopectin
 - e. Wetting properties of starch, amylose, and amylopectin films
- 3. Enzymic hydrolysis studies on starch
 - a. Debranching enzyme
 - b. Role of α -amylase in raw starch hydrolysis
- 4. Dextrose derivatives
 - a. Amino hexose-reductones
 - b. Fatty acid derivatives of glucose
 - c. Solubility of dextrose and other sugars in organic solvents
- C. Proteins
 - 1. Extraction, fractionation, and electrophoretic characterization of the component protein of corn
- D. Fermentation
 - 1. Microbial polysaccharides from starch
 - 2. Microbial proteins from grain
 - 3. Carotenoids from molds
 - 4. Plant diseases antibiotic
 - 5. Polymerization of fermentation acids
- E. Research on wheat
 - 1. Milling
 - a. Conditioning
Literature survey on effect of hot conditioning on flour properties and yield
 - b. Relation of kernel structure to millability of soft red winter wheat
 - c. New milling methods
 - 2. Malting
Effect of conditions and variety on amount and ratio of proteolytic and amylolytic enzymes
 - 3. Continuous batter process for separation of starch and gluten (will be demonstrated in pilot plant).
 - 4. Fundamental properties of gluten

5. Chemical modification of flour and gluten
6. Bread staling
 - a. Relationship of chemical structure to antifirming action of additives (will be reported on this morning)
 - b. Role of moisture transfer within loaf

F. Research on small grains

1. Pigments of sorghum grain
(Pigments of yellow endosperm varieties)
2. Minor constituents of barley
3. Oat gums
(Composition and structure of viscosity-producing components of oat groats)

V. PROGRESS REPORTS ON SELECTED PROJECTS AT
THE NORTHERN UTILIZATION RESEARCH AND
DEVELOPMENT DIVISION

A. Report of Work Under Corn Industries Research Foundation Fellowship:
Properties of Starch Components Separated by Sedimentation
Fractionation (Edna M. Montgomery).

Critical investigation of the extraction-sedimentation method for starch fractionation in aqueous dispersions has shown that the yield and purity of amylose in the centrifugal supernatants is greatly increased by pretreating the granular starch with certain aqueous organic solvents. In first centrifugal supernatants the yield of amylose is about 75 percent of that present in the starch. The amylose is obtained free from amylopectin.

Amylopectin, the fraction sedimented at 2,000 g., is obtained in coherent form and is free of linear starch after two or more additional extractions. Examination of a laboratory-prepared corn amylopectin revealed the presence of about 10 percent of branched material of approximately the size of amylose and of intermediate iodine affinity when compared with amylose and amylopectin. The intermediate fraction was soluble in alkali.

The new method has been used with success on wheat and potato starch also. Amylomaize (high-amylose corn starch) has been fractionated completely by this method judging from the results of other workers using the Schoch procedure.

One advantage of the method is that pure amylose may be isolated and studied in solution. By varying the time, temperature, and concentration of solvents in the starch pretreatment, it has been possible to vary the intrinsic viscosity of the extracted amylose by a factor of more than 2. Stability of 0.3-0.4 percent amylose solutions in water at pH 4.2 toward retrogradation and drop in intrinsic viscosity has been markedly increased by addition of 0.5 N sodium chloride. Investigations of changes in molecular shape or aggregation responsible for the unusual viscosity properties of amylose are being carried out.

B. Glucose Derivatives as Bread Softeners (Charles L. Mehlretter).

Bread softening agents are of importance to both the baking industry and the consumer because they allow longer storage of bread before staling occurs. The firmness of the loaf is of major significance in the staling phenomena from the consumer's viewpoint. Results of our antifirming evaluation study in which a series of synthetic and natural products were investigated as bread softening agents were reviewed. The products synthesized for evaluation were 3-stearoyl-D-glucose, 3-palmitoyl-D-glucose, D-glucose, monostearate, ascorbyl stearate, ascorbyl palmitate, ascorbyl myristate, isoascorbyl palmitate, hydrogenated ascorbyl palmitate, triacetyl ascorbyl palmitate, dimethylamino-hexose structure, stearoyl-D-gluconolactone, palmitoyl-D-gluconolactone, N-octyl D-gluconamide and N-dodecyl-D-gluconamide. Others were obtained from the manufacturers.

It was found that of all the products examined only 3-stearoyl-D-glucose is as good a bread softening agent as the best commercial additive, poly-oxyethylene monostearate, whose use has recently been banned by the Food and Drug Administration.

Methods used to prepare 3-stearoyl-D-glucose were given in some detail. The synthesis of the other products were only briefly described.

C. Corn Cleaning Methods and Batter Process (E. L. Griffin).

At a previous meeting of this group, Mr. Jesse R. Dilley discussed in some detail the problem of rodent contamination of corn. Most of the group were aware of the problem involved in removing rat "pellets" from shelled corn for the dry milling industry.

A variety of methods has been tried over the years, including repeated screening, washing, flotation and electrostatic separation. Some of the methods have been fairly successful, but results have varied and there still is demand for better separation.

In our pilot plant we are considering several new methods for accomplishing this separation based on different characteristics of the rat pellets. Mr. Curt Wohlrabe will demonstrate separations by conductivity, crushing, and color.

We will also demonstrate a continuous "batter process" pilot plant for separation of wheat flour into gluten, starch, and solubles fractions. This unit is constructed entirely of standard parts and could be readily duplicated on a commercial scale. Mr. Roy Anderson will show this unit.

D. Composition of the Cementing Layer and Adjacent Tissues as Related to Germ-Endosperm Separation in Corn (Michael J. Wolf).

Efficiency of degermination has a marked influence on the yield of oil in both corn wet and dry milling. Information on the composition of tissues and materials in the critical region of the corn kernel where germ and endosperm meet is basic for an understanding of the factors involved in degermination and in designing new degermination procedures.

A thin layer of amorphous material, the "cementing layer," holds the germ and endosperm together. Adjacent to it, on the endosperm side, is the "compressed layer," composed chiefly of walls of endosperm cells with little or no cell contents; and, on the germ side, the scutellar epithelium.

Histochemical studies showed that both the compressed layer and the epithelial cell walls contained cellulose and pentosans. Considerable protein was found (Kjeldahl analysis of microgram quantities) in the cementing layer and some pentosan. Pectic substances were absent in the region and likewise fatty membrane substances and emulsions. (Oil is found only within the epithelial cells in this area).

Certain crude enzymes were found which brought about separation along the germ-endosperm interface in corn sections. Enzyme 19, the most active of these, was fractionated and the effect of the fractions was studied to determine composition of the material being degraded in germ-endosperm separation.

The pectic-enzyme fraction (polygalacturonase and pectinmethylesterase) and the cellulase fraction were without effect on separation of germ and endosperm when applied to corn sections. Fractions containing cellulase and pentosanase caused a clean separation over the tips of the epithelial cells of the scutellum with evidence of degradation of the epithelial cell walls. The cementing layer and the compressed layer were relatively unaffected by the enzyme treatments.

The importance of pentosanase in the separation was emphasized by analysis of the enzymic hydrolyzate of corn sections by paper chromatography. Pentosan degradation products were found within 2 hours and increased in amount with time. Cellulase yielded only tracts of glucose after 24 hours and degradation products of pectic substances were not found.

The results indicate that pentosans, particularly those of the epithelial cell walls, are the most labile constituents in the interfacial region between germ and endosperm. In devising improvements of industrial procedures for degermination, special attention should be given to solution or degradation of these substances.

E. Type Reactions of Microorganisms (L. L. Wallen).

A method of preparing organic compounds which is steadily assuming increased importance involves the use of microorganisms to carry out one or more steps in the process. Some of the difficulties encountered by the chemist who desires to use microorganisms in this manner arise from (1) the large number of literature references through which he must search, (2) the need for basic information on how to cultivate and maintain microorganisms, and (3) the lack of knowledge as to where pure cultures can be obtained. In addition, one must have a general familiarity with fermentative procedures and the requirements for sterility.

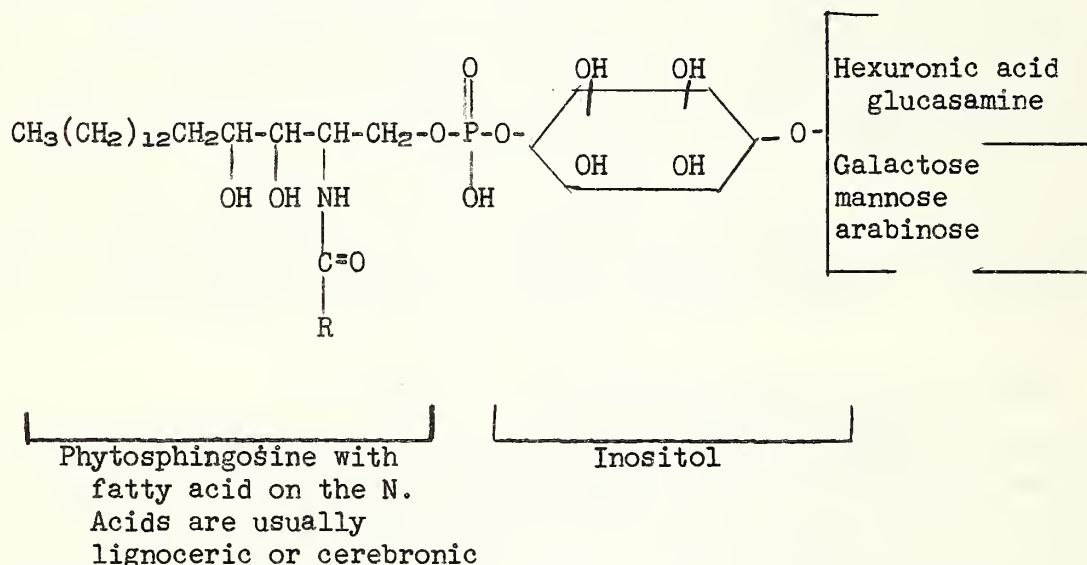
A microbiological type reaction bulletin containing prefatory chapters which deal with these problems is being prepared by Drs. Stodola and Wallen. The major portion of the bulletin will consist of over 1,100 examples of the earliest known published account of all the single-step, type chemical reactions which are performed by microorganisms. These reactions are to be classified according to the following headings: OXIDATION, REDUCTION, AMINATION, DEAMINATION, HYDROLYSIS, DEHYDRATION, ESTERIFICATION, DECARBOXYLATION, METHYLATION, CONDENSATION, GLYCOSYLATION, AMIDATION, ASYMMETRIC DISMUTATION, and ACETYLATION. Additional references to reviews, books and monographs will be included. Prefacing the section on type reactions, chapters will summarize historial development of the field of microbiology, discuss the microorganism, describe the equipment which is necessary, and deal with the fermentation itself.

This bulletin is being prepared for use by those members of our staff who desire to employ microorganisms for the utilization of agricultural products. It is hoped that it will also find use in other Government laboratories, in universities and in industry.

F. Cereal Grain Lipids (L. H. Mason).

Two new lipides have been found in cereal grains. The first, which is called phytoglycolipide, was discovered in a study of sphingolipides, (lipides containing a long chain base), of soybean under a research contract of NURDD with H. E. Carter at the University of Illinois. Phytoglycolipide has been isolated from corn and soy, and flax inositol lipides using the Thannhauser-Schmidt mild alkaline hydrolysis method. It is present only in traces in wheat flour lipides. Phytoglycolipide is soluble only in pyridine and aqueous base.

The structure of corn phytoglycolipide so far revealed is as follows:



Soy phytoglycolipide shows a trans double bond in the infrared spectrum and has more palmitic acid on the phytosphingosine nitrogen.

Phytoglycolipide is the first plant lipide isolated containing both long-chain base and inositol, and the first example of a plant lipide containing glucosamine.

A second new lipide from cereal grains is digalactosyl glyceride from wheat which is of interest to us because of its possible relation to the baking quality of wheat flours. The first object of our study was to determine whether differences in baking quality of wheat flours could be correlated with phosphatide composition.

Ponca (good) and Red Chief (poor), hard red winter wheat flours were extracted with wet butyl alcohol. The extracts were fractionated into acetone-soluble lipides, 50 percent alcohol wash, and phosphatides. Comparison of yields of the fractions showed that more phosphatide was isolated from Red Chief flour. Analytical data indicated similarities between the two phosphatide fractions. However, the data showed that some lipide was transferred into the Ponca alcohol wash. There was visual evidence that Ponca lipides possess more emulsifying power than those of Red Chief.

Countercurrent distribution of phosphatides of both flours were run. A major peak in both contains digalactosylglyceride, with more in Ponca than in Red Chief. Results of paper chromatographic studies on the distribution fractions indicated that most fractions were not homogeneous, however concentration of some compounds did occur. More work needs to be done on countercurrent distribution of phosphatides.

The digalactosyl glyceride was first isolated by Carter at the University of Illinois from benzene extracts of bleached wheat flour. Both mono- and digalactosyl glycerides were obtained. Carter showed the carbohydrate portions to be β -D-galactopyranosyl-1-glycerol and α -D-galactopyranosyl-1,6- β -D-galactopyranosyl-1-glycerol. We have found that the fatty acids which are attached to the glycerol contain palmitic, oleic, and linoleic acids.

G. Action of Various Oxidants on Periodate Oxidized Starch (R. L. Mellies).

Periodate oxidized starches on treatment with chlorous acid are preferentially oxidized with conversion of the aldehyde groups at the 2,3 positions to carboxyl groups. The sodium salts of the latter, even in quite low concentration, have viscosity properties resembling in some respects those of certain natural and synthetic carbohydrate gums. The oxidant is expensive and chlorine dioxide liberated as a byproduct is toxic and explosive. These factors stimulated an exploratory study on the use of various common oxidants which might convert aldehyde to carboxyl with a minimum of anomalous oxidation. Of especial interest was the viscosity of aqueous pastes of the products, the extent of conversion of carbonyl to carboxyl, and the yield of product which could be obtained without special processing methods. Five percent periodate oxystarch (five dialdehyde units per 100 monomer units) was used in these studies, since the product can be simply isolated by centrifugation or filtration.

Oxidants examined were sodium hypochlorite, sodium hypobromite, bromine water, hydrogen peroxide, and nitrogen dioxide. The reactions were generally run at room temperature and the effect of pH, molar ratio of oxidant to carbonyl and time of reaction related to the yield and properties of the products.

Carbonyl content was determined by pasting a sample in water and titrating with standard alkali or, for the sodium salts, by passage of the dilute paste through cation exchange resin and titration of the effluent. Carbonyl content was determined by the sodium borohydride reduction method, and also by the Somogyi method. The latter, because of the effect of hot alkaline copper reagent upon the aldehyde groups of periodate oxystarch probably gives anomalous results.

Bromine water, at a pH of about 2, gave the best results. Increase in the molar ratio of bromine to carbonyl from 1 to 4 with reaction time of about 24 hours gave a progressive increase in carboxyl and decrease in carbonyl. The product obtained at the highest molar ratio agreed closely in composition with that obtained in a control experiment using sodium chlorite as oxidant, although the viscosity of the 0.5 percent aqueous paste of the sodium salt did not approach that of the chlorite-oxidized product. This may be due to

difficulties in preparing the aqueous pastes, which may lead to degradation; or to degradation of the bromine-oxidized product on storage in the free acid form. (Later it was found that 6 percent periodate oxystarch, treated with only slightly more than the theoretical amount of bromine water at pH 2 for 156 hours gave about 72 percent conversion of carbonyl to carboxyl. The viscosity of a paste of this freshly-prepared material agreed well with that of the 6 percent periodate oxystarch after oxidation with sodium chlorite). Oxidations with bromine at pH's of 5.5, and 8 were less complete, although weight recoveries were excellent, as they were at the pH 2 level.

Sodium hypochlorite at pH's of 8.5, 6, and 4 proved to be non-specific for the oxidation, and caused considerable oxidative depolymerization, to give lowered yields, particularly with an excess of oxidant. The viscosity properties and composition of the products varied considerably from those of the chlorite-oxidized material. Sodium hypobromite was not better as an oxidant.

Hydrogen peroxide under acidic (pH 3 to 4) or alkaline (pH 8.5) conditions or in the presence of ferrous sulfate as catalyst was markedly inferior to other oxidants for conversion of carbonyl to carboxyl, and in almost all cases gave poor weight recoveries, indicative of fragmentation.

Gaseous nitrogen dioxide produced considerable carboxyl in the periodate oxystarch, much of it apparently arising at the 6-position, but also gave a fairly high carbonyl content, and a somewhat low weight recovery. Less carboxyl was produced when the oxystarch was dried prior to oxidation, or when nitrogen dioxide dissolved in carbon tetrachloride was used, and considerable amounts of carbonyl still remained. Nitrogen dioxide is also non-specific for the oxidation desired.

VI. DISCUSSION

A. Effect of Additives on Bread Firming

It is believed that 3-stearoyl-D-glucose, the most effective antifirming compound studied at the Northern Laboratory, would find a ready market at \$0.50 to \$0.60 per lb. Bakers could afford to pay this for the effect found at 45 hours after baking. The compound was tested with only one flour. Surface-active properties of the glucose-fatty acid derivatives should be measured to get possible correlation with bread-softening activity.

B. Corn Cleaning Methods

A combination of methods would probably work better than any one alone, because of the wide variation in composition of the pellets. The photo equipment could be hooked up to ejection equipment. Corn is prepared for the conductivity detection by flotation, washing and drying in a whizzer or basket centrifuge, or by spray, dewatering screen and tunnel dryer. This requires only equipment normally found in mills. Loss by the conductivity method, under ideal conditions, is 5 percent in one pass, and 5 percent of 5 percent in the second pass. Pulverizing rat pellets by impact has been tried at the Northern Laboratory, but losses are high because of breakage of corn kernels. Mouse pellets are best removed by screening. CIRF will send to NURDD a copy of the industry's committee's report to Food and Drug Administration on corn contamination.

C. Batter Process

The pilot plant equipment has been in operation only since March. Starting with 100 lbs. flour (d.b.), products are 10-12 lbs. gluten, 75 lbs. starch, and 5-7 lbs. soluble substances. After the first separation there is 4 percent protein in the starch, 60 percent protein in the gluten, and 8-10 percent lipids and about 30 percent starch in the gluten. After the gluten is washed and over the second screen, the protein content is 75-80 percent and the starch content 15-18 percent. Three parts of water to one of flour (d.b.) are being used, but the amount of water could be cut considerably and water could be recycled. The process has been found to be applicable to flours with from 8 to 18 percent protein. Studies on gluten drying are in progress.

D. Wetting Properties of Films

On request, F. R. Senti briefly described work in progress under contract at the University of Illinois. The wetting properties of films of whole starch, amylose and amylopectin, derivatives of these and selected synthetic polymers are being studied. Measurement of the contact angles of organic liquids on the films gives the energy of interaction or adhesion of starch, etc., to the liquids. Amylose film was found to be more wettable than amylopectin film. This data will form a basis for comparison of the adhesion properties of starch and other polymers. The wettability of polymers into which various polar groups has been introduced is being studied to determine the

effect of systematic change in polymer structure. Results on starch are being compared with corresponding properties of cellulose derivatives. Professor Ray hopes to finish his project this fall.

E. Suggestions for Future Work

1. Rheological Properties of Starches. Fundamental studies of rheological properties of starch pastes were urged. In the paper industry, especially, new methods have created problems in rheology that affect the use of starch. It was suggested that the Northern Laboratory might participate in the program set up by TAPPI.

2. Effect of Sound Waves on Starches. It would be of interest to know the effect of sound waves over a range of frequencies on starches. An idea might be obtained on states of aggregation in the colloidal starch-water system, without disturbing it too much. It is known that ultrasonic waves will rupture starch molecules.

3. Type Reactions of Microorganisms. It was suggested that this compilation be extended to cover conversions and transformations of starch.

F. Requests Made of the CIRF Technical Committee

1. It was agreed that a sub-committee be appointed within the Technical Committee to review the report to the President on Cereal Grains and to advise NURDD on what lines of fundamental research would give the most urgently needed information to the industry.

2. The Technical Committee was asked to discuss ways of supplying NURDD with information at future utilization conferences on the practical applications of starch in one or more selected fields. Particularly desirable would be discussions of applications wherein starch is losing ground to competitive substances and suggestions of fundamental studies on starch systems which might provide a basis for improved or extended use of starch. Possibly NURDD could initiate such studies designed to improve the competitive position of starch in these critical fields. The discussion could be kept general so that competition within the corn milling industry would not be a deterrent factor.

G. Commendations

The strong trend toward more fundamental studies and less developmental work at the Northern Laboratory was highly commended by the CIRF members. The compilation of type reactions of microorganisms and the progress on corn cleaning methods was work specifically commended.

H. Future Meetings

The value of the Annual Conferences between CIRF and NURDD and the desirability of continuing them was stressed. It was decided that the 1958 conference should start at 9:30 a. m. on a date to be set later.